

6.3.2 Water Demand Projection of the Study Area

(1) Municipal Water Demand Projection

(a) Domestic Water Demand Projection

Domestic water demand is projected by applying the following factors, mostly based on the data and information of EAAB and CAR. The population projection of the Study Area is set up as shown in Table-6.6.

Table-6.6 Population of the Study Area (Unit: 1000 persons)

Region		2000	2005	2010	2015	Growth (%)
Bogotá D.C.		6,485	7,283	8,087	8,879	2.1
Municipalities	13 (close to Bogotá)	842	1,022	1,221	1,438	3.6
	17 (others)	167	172	179	189	0.8
Sub-total		1,009	1,194	1,400	1,627	3.2
Total		7,494	8,477	9,487	10,506	2.8

Note: Growth is an average per annum during 2000 and 2015.

The distribution of population by each river basin is conducted by the Study Team as shown in Table-6.7. The distribution is made based on the population and municipality area.

Table-6.7 Population by River Basin (1,000 persons)

River Basin		2000	2005	2010	2015	Growth (%)
1	Bogotá 1	1.4	1.1	0.9	0.7	-4.8
2	Bogotá 2	396.7	499.7	629.5	793.0	4.7
3	Bogotá 3 East City	2,086.3	2,318.4	2,576.5	2,863.2	2.1
4	Bogotá 3 East Hills	820.1	911.4	1,012.8	1,125.5	2.1
5	Bogotá 3 West	120.8	136.5	154.2	174.3	2.5
6	Bogotá 4	307.3	342.2	381.0	424.2	2.2
7	Bogotá 5	206.7	232.6	261.7	294.5	2.4
8	Bogotá 6	77.9	88.2	99.8	113.0	2.5
9	Bogotá 7	27.0	31.3	36.3	42.0	3.0
10	Bogotá 8	8.6	9.3	10.1	10.9	1.6
11	Bogotá 9	20.8	20.5	20.1	19.8	-0.3
12	Bojacá	87.8	97.3	107.9	119.6	2.1
13	Chicu	27.0	32.8	39.9	48.5	4.0
14	Frio	46.6	48.4	50.2	52.2	0.8
15	Neusa	28.8	27.9	27.0	26.1	-0.7
16	Sisga	5.5	4.8	4.1	3.6	-2.9
17	Muña	24.1	24.3	24.6	24.8	0.2
18	Subachoque 1	1.1	1.1	1.1	1.2	0.1
19	Subachoque 2	77.4	86.7	97.3	109.0	2.3
20	Teusaca	313.9	349.4	388.9	432.9	2.2
21	Tominé	12.0	11.5	10.9	10.4	-1.0
22	Tunjuelito	2,796.8	3,101.1	3,439.7	3,816.2	2.1
	Total	7,494.6	8,376.5	9,374.5	10,505.6	2.3

Other unit rates for water demand projection are set as shown in Table-6.8.

Table-6.8 Unit Rates for Water Demand Projection

Items	Region		2000	2005	2010	2015
Unit Consumption Rate (liter/person/day)	Bogotá D.C.		115.6	112.5	109.3	109.3
	Municipalities	13 (close to Bogotá)* (minimum/maximum)	118.8 (103.0/182.2)	118.0 (103.0/182.2)	117.5 (103.0/182.2)	117.1 (103.0/182.2)
		17 (others)* (minimum/maximum)	132.2 (93.9/185.8)	131.9 (107.0/179.7)	130.1 (120.5/173.0)	127.0 (134.4/165.8)
		Subtotal	121.0	120.0	119.1	118.3
	Total		116.3	113.5	110.7	110.7
Service Coverage Ratio (%)	Bogotá D.C.		88.1	90.7	90.7	90.7
	Municipalities	13 (close to Bogotá)* (minimum/maximum)	87.4 (54.0/97.9)	88.4 (58.6/98.0)	89.4 (62.7/98.1)	90.4 (66.5/98.2)
		17 (others)	80.0	82.0	83.8	85.4
		Subtotal	86.1	87.5	88.7	89.8
	Total		87.8	90.2	90.4	90.6
Water Loss Rate (%)	Bogotá D.C.		31.2	31.0	31.2	31.3
	Municipalities	13 (close to Bogotá)** (minimum/maximum)	32.4 (18.2/34.2)	32.4 (18.1/34.2)	32.4 (18.2/34.2)	32.4 (18.3/34.2)
		17 (others)	35.0	35.0	35.0	35.0

Note: 1) * ; an average weighted with each municipality population, 2) **; a simple average

Considering all data and information above mentioned, the water demand by water source is projected, the result of which is shown in Table-6.9.

Table-6.9 Projected Domestic Water Demand (Unit: 1000m³/day)

Water	Region		2000	2005	2010	2015
Surface Water	Bogotá D.C.		960	1,077	1,165	1,281
	Municipalities	13 (close to Bogotá)	117	139	166	198
		17 (others)	26	27	28	27
		Sub-total	143	166	194	225
Total		1,103	1,243	1,359	1,506	
Groundwater	Bogotá D.C.		0	0	0	0
	Municipalities	13 (close to Bogotá)	9	11	13	14
		17 (others)	6	6	7	9
		Sub-total	15	17	20	23
Total		15	17	20	23	
Total	Bogotá D.C.		960	1,077	1,165	1,281
	Municipalities	13 (close to Bogotá)	126	150	179	212
		17 (others)	32	33	35	36
		Sub-total	158	183	214	248
Total		1,118	1,260	1,379	1,529	

(b) Non-domestic Water Demand Projection of the Study Area

Non-domestic water demand on surface water is projected based on 2 projections; the demand projection of Bogotá D.C. by EAAB and the demand projection of Cundinamarca by CAR. According to the EAAB projection, the demand of Bogotá D.C. will rise in line with GDP growth rate that is approximately 4% per annum. According to the CAR projection, commercial and public water demand is estimated at 3.45% of the domestic water demand, while industrial-water demand is presumed by the Study Team; to grow also by 4%.

On the other hand, actual groundwater demand is obtained from actual consumption data of DAMA and concession volume extracted from well inventory compiled by the Study Team. Based on this actual data, the groundwater demand of non-domestic use is also projected to grow by 4% per annum.

Taking into account all above data, non-domestic water demand are projected as presented in Table-6.10.

Table-6.10 Projected Non-domestic Water Demand (Unit: 1000m³/day)

Water	Region		2000	2005	2010	2015
Surface Water	Bogotá D.C.		284	369	443	536
	Municipalities	13 (close to Bogotá)	22	29	36	43
		17 (others)	4	4	4	4
	Sub-total		26	33	40	47
Total			310	402	483	583
Groundwater	Bogotá D.C.		15	19	22	27
	Municipalities	13 (close to Bogotá)	7	8	10	12
		17 (others)	3	4	5	6
	Sub-total		10	12	15	18
Total			25	31	37	45
Total	Bogotá D.C.		299	388	465	563
	Municipalities	13 (close to Bogotá)	29	37	46	55
		17 (others)	7	8	9	10
	Sub-total		36	45	55	65
Total			335	433	520	628

(2) Irrigation Water Demand Projection of the Study Area

(a) Floriculture

The current water use of floriculture in the Study Area is summarized in Table-6.11. According to ASOCOLFLORES, the cultivated area of flower extends to 5,800ha at present in the Bogotá Plain. Unit consumption rate is 0.30 liter/second/ha. Groundwater demand amounts to 80% of total water demand; the rest of 20% relies on rain water collected in the ponds.

Table-6.11 Current Water Use of Floriculture

Items		Remarks	Amount	Unit
Area	Total	Bogotá Plain; according to ASOCOLFLORES	5,800	ha
	Registered	ICA (Instituto Colombiano de Agropecuario)	4,043	ha
Unit Consumption		Statistic data of ASOCOLFLORES	0.30	liter/second/ha
Total Water Use			150	1000m ³ /day
Groundwater		80% of the total water use according to ASOCOLFLORES	120	1000m³/day

According to ASOCOLFLORES, such high growth rate as before cannot be expected in the future caused by high competency in the US market. Taking into account this market conditions, the water demand is projected to grow by 2% per annum.

Thus, the floriculture water demand is projected as shown in Table-6.12.

Table-6.12 Projected Floriculture Water Demand (Unit: 1000m³/day)

Water	2000	2005	2010	2015
Surface Water	30	33	36	40
Groundwater	120	133	147	162
Total	150	166	183	202

(c) Agriculture

According to CAR study, agriculture water demand currently amounts to 22m³/second in Bogotá Plain. Meanwhile, intake amount from rivers for agriculture use is estimated at 10.52m³/second by the Study Team. Besides, the groundwater demand on agriculture use is estimated at 1.85m³/second according to the well inventory and other well information. The rest of the demand might be considered to depend on rainfall. Based on the data, agriculture demand is projected as shown in Table-6.13.

Table-6.13 Projected Agriculture Water Demand (Unit: 1000m³/day)

Water	2000	2005	2010	2015
Surface Water	909	932	955	980
Groundwater	160	164	168	173
Total	1,069	1,096	1,124	1,152

(3) Overall Groundwater Demand of the Study Area

Total demand of both surface water and groundwater in 2015 is summarized in Table-6.14. Municipal water demand is estimated at 2,157,000m³/day (24.96m³/second), of which 68,000m³/day (0.78m³/second) is groundwater. Irrigation water demand of the Study Area is estimated at 1,355,000m³/day (15.67m³/second), of which groundwater demand is 335,000m³/day (3.87m³/second). Thus total groundwater demand is estimated at 403,000m³/day (4.65m³/second) in 2015.

Table-6.14 Total Water Demand of the Study Area

Water Use	Water Source	2000		2015		
		1000m ³ /day	m ³ /second	1000m ³ /day	m ³ /second	
Municipal Water	Domestic	Surface Water	1,103	12.77	1,506	17.43
		Groundwater	15	0.17	23	0.26
		Total	1,118	12.94	1,529	17.69
	Non-domestic	Surface Water	310	3.58	583	6.75
		Groundwater	25	0.29	45	0.52
		Total	335	3.87	628	7.27
	Total	Surface Water	1,413	16.35	2,089	24.18
		Groundwater	40	0.46	68	0.78
		Total	1,453	16.81	2,157	24.96
Irrigation Water	Flower	Surface Water	30	0.35	40	0.47
		Groundwater	120	1.39	162	1.87
		Total	150	1.74	202	2.34
	Agriculture	Surface Water	909	10.52	980	11.33
		Groundwater	160	1.85	173	2.00
		Total	1,069	12.37	1,152	13.33
	Total	Surface Water	939	10.87	1,020	11.80
		Groundwater	280	3.24	335	3.87
		Total	1,219	14.11	1,355	15.67
Total	Surface Water	2,352	27.22	3,109	35.98	
	Groundwater	320	3.70	403	4.65	
	Total	2,672	30.95	3,512	40.63	

<Groundwater Demand by River Basin and by Sector>

The distribution of groundwater demand a by each river basin is conducted by the Study Team as shown in Table-6.15.

Table-6.15 Groundwater Demand (m³/second)

Basin		Domestic		Non-domestic		Flower		Agriculture		Total	
		2000	2015	2000	2015	2000	2015	2000	2015	2000	2015
1	Bogotá (1)	-	-	0.004	0.008	0.005	0.007	0.002	0.002	0.012	0.017
2	Bogotá (2)	0.000	0.000	0.012	0.021	0.040	0.054	0.132	0.142	0.183	0.217
3	Bogotá (3) – Eastern City	-	-	0.074	0.134	-	-	0.110	0.119	0.184	0.252
4	Bogotá (3) – Eastern Hill	-	-	0.005	0.009	-	-	0.000	0.000	0.005	0.009
5	Bogotá (3) – Western	0.031	0.050	0.016	0.028	0.175	0.236	0.293	0.316	0.514	0.631
6	Bogotá (4)	0.014	0.025	0.009	0.016	0.022	0.030	0.238	0.258	0.284	0.329
7	Bogotá (5)	-	-	0.006	0.010	0.070	0.094	0.155	0.168	0.231	0.272
8	Bogotá (6)	0.009	0.014	0.001	0.002	0.005	0.006	0.001	0.001	0.016	0.023
9	Bogotá (7)	0.002	0.001	0.008	0.014	0.205	0.267	0.087	0.094	0.301	0.376
10	Bogotá (9)	0.005	0.007	0.000	0.000	0.005	0.007	0.001	0.001	0.011	0.015
11	Bogotá (9)	0.000	0.000	-	-	0.005	0.006	0.000	0.000	0.006	0.007
12	Bojacá	0.028	0.039	0.018	0.032	0.184	0.248	0.019	0.021	0.249	0.340
13	Chicu	0.035	0.058	0.004	0.007	0.117	0.157	0.361	0.390	0.517	0.612
14	Frio	0.001	0.001	0.001	0.002	0.058	0.078	0.084	0.091	0.144	0.172
15	Neusa	0.005	0.005	0.000	0.000	0.046	0.071	0.045	0.049	0.096	0.124
16	Sisga	-	-	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001
17	Soacha	-	-	0.005	0.009	0.010	0.013	0.000	0.000	0.015	0.022
18	Subachoque (1)	0.000	0.000	0.001	0.002	0.001	0.002	0.001	0.001	0.003	0.005
19	Subachoque (2)	0.043	0.066	0.016	0.028	0.346	0.466	0.228	0.247	0.634	0.808
20	Teusaca	-	-	0.012	0.021	0.086	0.116	0.070	0.076	0.167	0.212
21	Tominé	-	-	0.000	0.000	0.008	0.011	0.000	0.000	0.008	0.011
22	Tunjuelito	-	-	0.101	0.182	0.003	0.003	0.024	0.026	0.128	0.211
Total		0.174	0.266	0.291	0.523	1.392	1.873	1.876	2.002	3.709	4.655

6.3.3 Groundwater Demand Projection in the Development and Conservation Plan Area

(1) Groundwater Development and Conservation Plan for Eastern Hills

(a) Eastern Hills of Bogotá City

Eastern Hills of Bogotá City consists of 3 areas; 1) Bogotá City eastern hills, 2) Suba hills and 3) Soacha hills; however there is no statistic data on population of the Area. Therefore the Study Team estimates the population of the Area as shown in Table-6.16, based on the study report of EAAB. Population of the Area is estimated to reach 750,000 persons in 2015 or 7% of the total population of Bogotá D.C. and Soacha.

Table-6.16 Population Projection

Location	Site	Name of Tank	2000	2015	Growth (%)
Vitelma	Vitelma (Recharge & Water Supply)	El Consuelo	17,200	23,600	2.1
Santana & Chico	Usaquen (Water Supply)	Usaquen	15,000	16,000	0.5
	Chico (Water Supply)	Chico	35,000	37,700	2.1
Sub-total			50,000	53,700	1.7
Cerros Norte	Codito (Water Supply)	Codito	18,800	25,700	2.1
	Soratama (Water Supply)	Soratama	2,700	3,700	2.1
	Cerro Norte (Water Supply)	Cerro Norte	15,500	21,200	2.1
	Bosque Pino (Water Supply)	Bosque Pino	600	650	0.5
	Bosque Medina (Water Supply)	Bosque Medina	2,600	2,800	0.5
	Unicerros (Water Supply)	Unicerros	7,900	10,800	2.1
Sub-total			48,100	64,900	2.0
Soacha	Sierra Morena III (Water Supply)	Sierra Morena III	96,400	194,800	4.8
	Julio Rincon (Water Supply)	Julio Rincon	93,300	188,600	4.8
	Santillana (Water Supply)	Santillana	88,600	178,900	4.8
Sub-total			278,300	562,300	4.8
Suba	Medio Suba (Water Supply)	Medio Suba	21,800	29,800	2.1
	Alto de Suba (Water Supply)	Alto de Suba	14,400	19,600	2.1
	Sub-total			36,200	49,400

Total		429,800	753,900	3.9
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Other unit rates fro demand projection are set shown in Table-6.16.

Table-6.17 Unit Rates Projection

Location	Site	Name of Tank	Unit Consumption Rate (l/person/day)		Service Coverage Ratio (%)	Water Loss Rate (%)	
			2000	2015		2000	2015
Viterma	Viterma	El Consuelo	115.6	109.3	100	35	20
Santana & Chico	Usaquen	Usaquen	140.0	132.4	100	0	0
	Chico	Chico	140.0	132.4	100	21	20
Eastern	Codito	Codito	115.6	109.3	100	0	0
	Soratama	Soratama	143.5	129.7	100	47	20
	Cerro Norte	Cerro Norte	115.6	109.3	100	12	12
	Bosque Pino	Bosque Pino	170.0	160.7	100	20	20
	Bosque Medina	Bosque Medina	170.0	160.7	100	0	0
	Unicerros	Unicerros	115.6	109.3	100	45	20
Soacha	Sierra Morena III	Sierra Morena III	115.6	109.3	100	13	13
	Julio Rincon	Julio Rincon	115.6	109.3	100	30	20
	Santillana	Santillana	115.6	109.3	100	6	6
Suba	Medio Suba	Medio Suba	115.6	109.3	100	38	20
	Alto de Suba	Alto de Suba	115.6	109.3	100	20	20

Based on the above, groundwater demand in the Eastern Hills of Bogotá City is projected as presented in Table-6.18, which amounts to 0.736m³ in 2000 and 1.145m³ in 2015.

Table-6.18 Groundwater Demand Projection of Eastern Hills of Bogotá City

Location	Site	Name of Tank	2000	2005	2010	2015
Viterma	Viterma	El Consuelo	0.035	0.036	0.036	0.037
Santana & Chico	Usaquen	Usaquen	0.024	0.024	0.024	0.024
	Chico	Chico	0.072	0.078	0.084	0.091
Cerros Norte	Codito	Codito	0.025	0.027	0.030	0.033
	Soratama	Soratama	0.008	0.008	0.007	0.007
	Cerro Norte	Cerro Norte	0.024	0.026	0.028	0.031
	Bosque Pino	Bosque Pino	0.001	0.001	0.001	0.002
	Bosque Medina	Bosque Medina	0.005	0.005	0.005	0.005
	Unicerros	Unicerros	0.019	0.018	0.018	0.017
Soacha	Sierra Morena III	Sierra Morena III	0.148	0.184	0.228	0.283
	Julio Rincon	Julio Rincon	0.178	0.184	0.228	0.283
	Santillana	Santillana	0.126	0.156	0.194	0.241
Subtotal			0.667	0.775	0.908	1.069
Suba	Medio Suba	Medio Suba	0.046	0.046	0.046	0.046
	Alto de Suba	Alto de Suba	0.023	0.026	0.028	0.030
Subtotal			0.069	0.071	0.074	0.076
Total			0.736	0.846	0.981	1.145

(b) Northern Part of Eastern Hills

Groundwater development amount in the Northern part of Eastern Hills is planned at 1m³/second. The development volume will benefit to 550,000 persons.

(c) Total groundwater demand in Eastern Hills

The total groundwater demand of both Eastern Hills of Bogotá City and Northern Part of Eastern Hills will amount to; 1.736 m³/second in 2000 and 2.145 m³/second in 2015.

(2) Groundwater Water Resource Conservation Plan for Western Part of Bogotá Plain

The conservation plan in Central Area of Bogotá Plain contains 6 river basins. In the Area the irrigation use for such as flower and agriculture is overwhelming for groundwater demand,

which would amount to 2.157m³/second in 2000 and 2.611 m³/second in 2015 as presented in Table-6.19.

Table-6.19 Groundwater Demand on Irrigation in the Western Part of Bogotá Plain

River Basin	Flower		Agriculture		Total	
	2000	2015	2000	2015	2000	2015
1. Bogotá (3)- Western	0.175	0.236	0.293	0.316	0.468	0.552
2. Bogotá (7)	0.205	0.267	0.087	0.094	0.292	0.361
3. Bojacá	0.184	0.248	0.019	0.021	0.203	0.269
4. Chicu	0.117	0.157	0.361	0.390	0.478	0.547
5. Frio	0.058	0.078	0.084	0.091	0.142	0.169
6. Subachoque (2)	0.346	0.466	0.228	0.247	0.574	0.713
Total	1.085	1.452	1.072	1.159	2.157	2.611

6.3 Development and Conservation Plan

6.3.1 Groundwater Development and Conservation Project in Eastern Hills of Bogotá Plain (Eastern Project)

(1) Project Area

Areas of this project are located in Eastern Hills that includes Soacha area, Vitelma area, San Diego area, Santa Ana & Chico area, Cerros Norte area, Yerbabuena and Suba area.

(2) Purpose of project

This project is public works of environmental improvement with purpose of water supply and improvement of water environment.

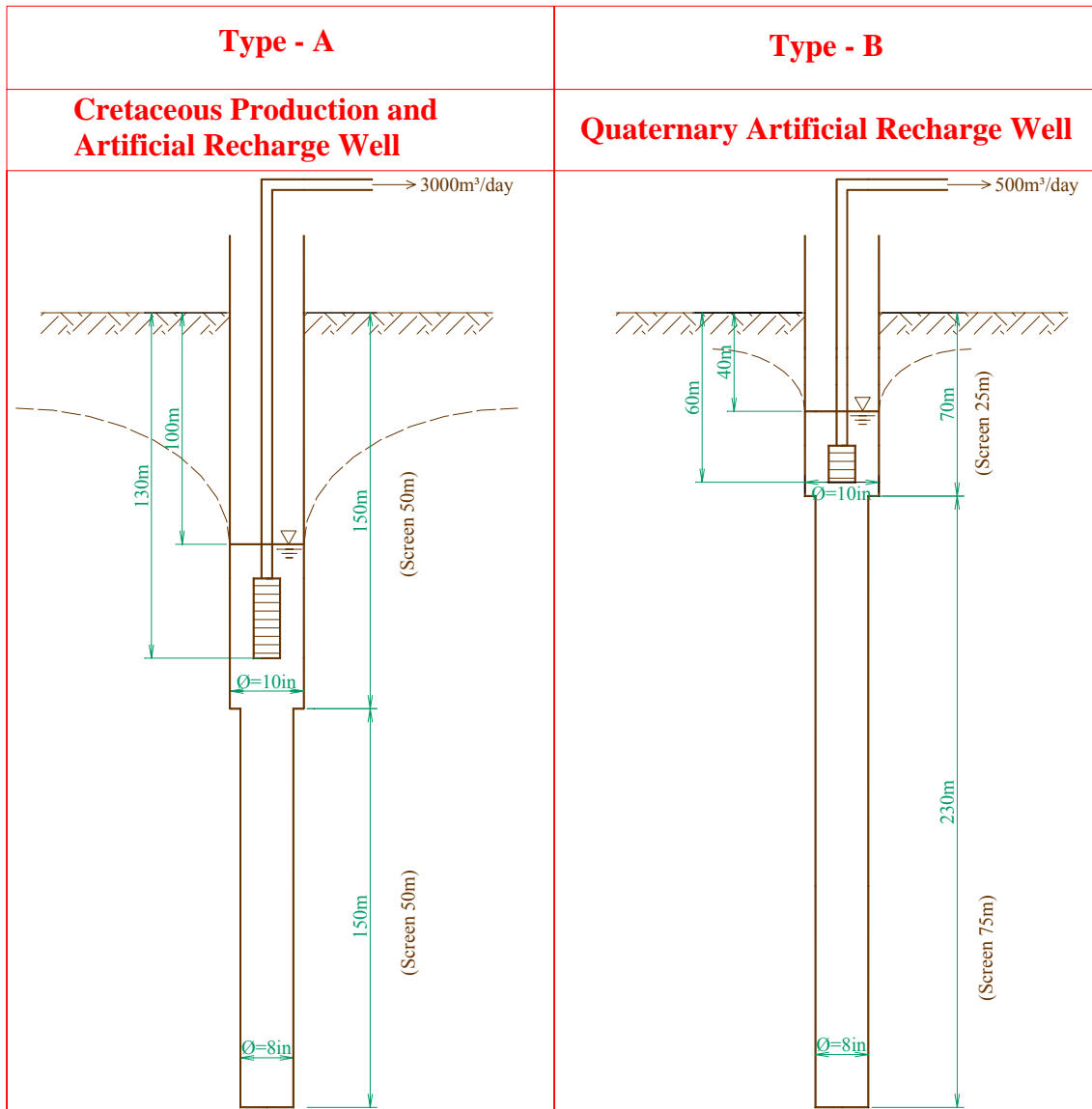


Figure-6.3 Standard Well Structure

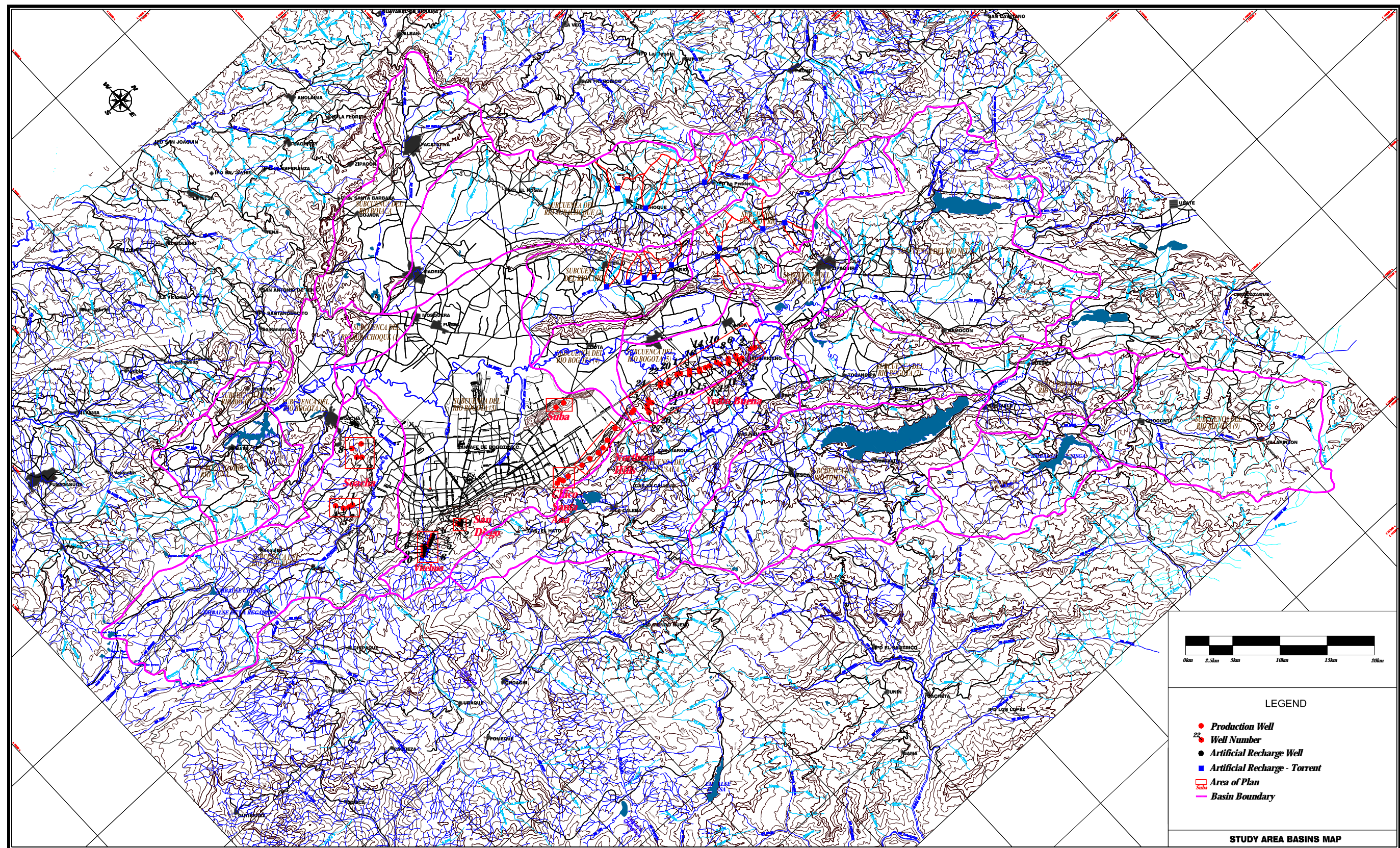


Figure-6.4 Well Plan for Development and Conservation of Groundwater

<Water supply for Bogotá City>

The amount of current water supply by EAAB to Bogotá City and neighbouring cities is 15m³/s. Amount of water supply is predicted to be 23m³/s in the year of 2015. The current water supply system of EAAB consists of three systems. Namely, Weisner System (Maximum purification capacity:12m³/s), Tibitoc System (maximum purification capacity:11m³/s), Southern System (maximum purification system:2m³/s).

Total amount of purification capacity reaches to 25m³/s. However, it is difficult to continue water supply of 25m³/s because of fluctuation of water volume at each water resource and interruption of operation for maintenance of purification plants. Especially, amount of current operation of Tibitoc purification plant is 6m³/s. Considering water quality improvement of Bogotá river by increase of discharge, irrigation use and hydroelectric power generation, EAAB is planning to reduce operation amount to 2m³/s in the near future though it is not decided when it will be implemented. Based on such a background, development of new water resource for water supply is urgently expected.

There is another subject on water supply in case of emergency. Weisner System has vulnerability against natural disaster such as earthquake, because in this system water is conveyed from Chingasa Dam, which is located 40km from the purification plans, through water tunnel in mountain area. In 1997, water supply was stopped from this system during 9 months. Moreover, development of new water resource in case of large-scale repairing of purification plant and pipeline is also important subject.

Based on background above, groundwater of 2m³/s (for usual case: all year) and 4m³/s (for emergency: during 6 months, once/15 years) will be developed in proposed project.

<Improvement of water environment>

New groundwater development for water supply will decrease water-intake at Tibitoc treatment plant. This decreased water-intake means increase of net discharge of Bogotá River and will contribute to improvement of water quality of Bogotá River.

Increased discharge of Bogotá River will increase dissolved oxygen and contribute improvement of water quality in the down-stream of Tibitoc purification plan, and will contribute to increase of hydroelectric generation of power station (Current operation of 20m³/s for all year) that is located at down most of Bogotá Plain.

(3) Content of Project

Production wells are designed to achieve propose of project considering groundwater potential and design water demand. Moreover, artificial recharge wells are designed for conservation of groundwater of the area. In this area, total amount of 0.5m³/s can be used for artificial recharge, which is currently taken by Vitelma purification plant in San Cristibal River and San Diego plant of San Francisco River. This water will become surplus water for artificial recharge, because both plants has been decided to be out of use. However, in case of emergency, recharge wells will be used for production wells. Specification and number of production and recharge well is shown in Table-6.20. Well arrangement in each block is as follows:

Cerros Norte area, Santana/Chico area, Suba Area, Soacha Area

New wells will be drilled next to existing tank for water supply. Pumped groundwater will be stored in existing tank for usual and emergent water supply. Facilities for purification will be constructed beside existing tank.

Vitelma Area and San Diego Area

Production wells will be newly drilled along San Cristobal and San Francisco River.

Groundwater pumped up from wells will be used through newly constructed purification facilities using existing pipelines for usual and emergent water supply to Eastern Hills Area of Bogotá City and Soacha Area. Artificial recharge wells will be drilled near production wells to use surplus river water, which can be used by abolition of Vitelma and San Diego purification plants. In case of emergency, groundwater will be pumped up even from artificial recharge wells against water shortage.

Yerbabuena Area

Production wells will be drilled in hills of Yerbabuena Area. Groundwater from wells will be joined to existing water supply system (Tibitoc – Bogotá City) through newly constructed purification facilities.

Table-6.20 Well Plan of Eastern project

Area	Aquifer	Well size	Well number	Maximum Capacity (m ³ /s)
Cerros Norte, Santana/Chico, Suba area. New wells will be drilled next to existing tank for water supply	Cretaceous	Well length: 300m Well diameter 10 inch Yield: 3,000m ³ /day/well Injection: 3,000m ³ /day/well	12	0.42
Soacha area. New wells will be drilled next to existing tank for water supply.			8	0.28
Vitelma and San Diego area.			Production wells: 13 Recharge wells: 13	0.45
Hills of Yerbabuena area, north of Bogotá City.			30	1.04
Total			Production wells: 63 Recharge wells: 13	<Production> Usual: 2.19 Emergency: 4.00 <Recharge> Usual: 0.45

(4) Beneficiaries of Project

Population of direct beneficiaries by water supply of this project is 1.3 million. Population of beneficiaries by water supply in case of emergency is more than 7.7 million that is the same as all supplied population by EAAB.

6.3.2 Groundwater Conservation Plan of Area of High Groundwater Use in Bogotá Plain (Western Project)

(1) Project Area

Area of this project is Subachoque River Basin, Chicu River Basin, Frio River Basin and area along middle reach to down-stream of Bogotá River, where groundwater is highly used. These areas are in western and center of Bogotá Plain, where groundwater is pumped up from Quaternary aquifer by more than 6,000 wells. In recent year, over-pumping is pointed out in these areas.

(2) Purpose of Project

This project is public works for environment with purpose of improvement of water quality as explained below:

<Groundwater recharge>

Purpose of this project is sustainable groundwater use without any trouble accumulation of groundwater potential for additional groundwater use in area where groundwater is highly used for irrigation and flower production.

<Lightening of burden from groundwater in water use>

In order to lighten the burden from groundwater in area where groundwater is highly used, research and development of technology should be implemented until practical level. This study should include utilization of alternative water resource for irrigation and flower production improvement of efficiency for irrigation.

(3) Content of project

In order to achieve purpose of project, two sub-projects should be implemented. Namely, groundwater recharge project and research and development of technology for groundwater use.

<Groundwater recharge project>

Artificial recharge should be implemented in up-stream of area where pumping wells distribute. Water resource for artificial recharge is river water of torrent in up-stream of Subachoque, Chicu and Frio River basins. In these areas, river water is highly used. Therefore, surplus water in flood in rainy season should be used for artificial recharge. Artificial recharge plan is shown in Table-6.21.

Table-6.21 Well Plan of Western Project

Area	Aquifer	Well size	Number of recharge well	Maximum recharge capacity
Subachoque Basin	Quaternary	Well length 300m Well diameter 10 inch Injection rate : 1,500m ³ /day/well/2 sites	8 wells in 4 sites	0.14
Chicu Basin			10 wells in 5 sites	0.18
Up-stream of Frio Basin			10 wells in 5 sites	0.18
Total			28 wells in 14 sites	0.50

<Research and development of technology for groundwater use>

Technology for groundwater use should be researched and developed to lighten the burden of groundwater use in the project area.

- Reuse of drained water of irrigation
- Use of rainfall for irrigation
- Use of surface water of Bogotá River for irrigation
- Transfer to new area for future projects of flower production.
- Improvement of irrigation efficiency (including use of groundwater thermal property)

(4) Beneficiaries of Project

Population of beneficiaries of this project reaches 200 thousand that belongs to agricultural sector.